Report of the Survey Design Meeting for Estimating Abundance of Eastern Tropical Pacific Dolphins, 1998-2000

December 17-18, 1997

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La Jolla, CA

April 1998

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INTRODUCTION

With the International Dolphin Conservation Program Act (Public Law 105-42), passed in August 1997, Congress directed the National Marine Fisheries Service to determine if the tropical tuna purse-seine fishery in the eastern tropical Pacific (ETP) is having a significant adverse impact on depleted dolphin stocks. To aid in this determination, Congress has mandated that dolphin population surveys be undertaken in each of the calendar years 1998, 1999, and 2000 to generate new abundance estimates.

On December 17-18, 1997, the Southwest Fisheries Science Center (SWFSC) convened a technical meeting to discuss methods of estimating dolphin abundance. In addition to SWFSC scientists, the meeting was attended by representatives of the Alaska Fisheries Science Center, the Marine Mammal Commission, the Inter-American Tropical Tuna Commission (IATTC), and the Mexican and Ecuadorian governments (Appendix 1).

The overall objective of the meeting was to review the survey design for estimating the abundance of dolphins in the eastern tropical Pacific. This report will follow the order of topics discussed at the meeting (Appendix 2).

BASIC CRUISE ELEMENTS AND METHODOLOGY

In the past 15 years, the SWFSC has refined and standardized a shipboard visual line transect method of surveying for cetacean abundance. The Monitoring of Porpoise Stocks (MOPS) survey, conducted 1986-1990, used this methodology. In general, similar methods will be used for the new survey so that data collected will be comparable to those from past surveys, in particular, MOPS.

Boundaries of the new study area will be similar to the MOPS area. The area is an exceedingly large, several million square mile region in the eastern tropical Pacific (ETP), where tuna fishing vessels set on dolphin schools. Discussion regarding changes to the MOPS boundaries follows later. Three survey vessels are planned for the 1998 cruise and two vessels for the cruises in 1999 and 2000. As the third vessel for the 1998 cruise, NMFS is trying to procure the R/V WORTHY, an acoustically quiet vessel originally built for the Navy. Workshop participants agreed this would be an excellent survey platform. Cruises will be conducted July-December as they were during MOPS, with 120 sea days per ship. The focal populations of this survey are the depleted stocks of offshore spotted dolphins and eastern spinner dolphins.

Gerrodette detailed data collection procedures aboard the ships. A visual watch for cetaceans is conducted from dawn to dusk, in weather up to Beaufort 6, by rotating teams of three observers. Two observers search with 25X binoculars, scanning the 180 forward of the ship. The 25X binoculars are fitted with azimuth rings and reticles for angle and distance measurements. Distance to sightings made with reticles have been checked against distance measured with radar to verify the accuracy of this method. The third observer acts as data recorder and searches by eye. The area from the ship out to 300 meters is not visible in the 25X binoculars, so the recorder concentrates his/her searching effort there. Data are entered into a portable computer. When a marine mammal is sighted the angle and distance to the sighting are measured and recorded. The team goes

"off-effort" and into a "closing mode" where the ship is directed to leave the transect line and approach the animal(s) sighted. Upon close approach the observers identify to species and make group size estimates of the animal(s) sighted. Every observer team has at least one observer highly experienced in the field identification of marine mammals. Observers estimate group sizes independently and give best/high/low estimates. Aerial photogrammetry from a helicopter on one of the ships is used to check the accuracy of school size estimates and to develop a correction factor for each observer.

Concern was expressed about entering data directly into a computer. It was explained that the data are automatically saved and backed up onto the hard drive and a floppy, and the files are not open at the same time. Losing data has not been a problem since this procedure was instituted. What about the ship's heading following a sighting? Does the ship resume its former course, thus continuing on a line parallel to the trackline, or does the ship angle back to the trackline? The ship continues on a parallel course, returning to the trackline at night for the start of the next day. Procedure regarding two simultaneous sightings was questioned. In this case the sightings would be investigated one at a time. If the second sighting happened to be lost, preliminary estimates of school size and species identification could be used. However, since this scenario happens very infrequently, there would be no effect on the estimated abundance.

This led into a discussion of closing versus passing mode. The International Whaling Commission uses passing mode for its minke whale surveys. Passing mode has the advantage of surveying more miles in a given time period than closing mode. Barlow tried a combination of closing and passing modes for an abundance survey that he conducted off California, Oregon, and Washington in 1996. He found that the closing/passing mode combination was not very efficient. In passing mode it was difficult to get species identification and group size estimates. The passing mode days became lost data days for these quantities. Barlow therefore recommended closing mode, although he suggested modifying closing mode so as to minimize any potential biases and advised the consistent recording of off-effort sightings while closing to allow modeling of possible bias.

It was queried whether the ships' drafts changed during a cruise. The draft of the Antarctic minke whale survey vessels changes more than a meter during a cruise. The draft is recorded and the height/distance angle is adjusted accordingly. It was noted that this was indeed a good point. It had not been kept track of on past SWFSC cruises and would be investigated.

Gerrodette solicited comments on whether it was a good idea to tell experienced observers, before starting this survey, the accuracy of their group size estimates from past surveys. A discussion ensued although no consensus pro or con was reached. If observers are informed of the accuracy of their past estimates, their performance may improve. Alternatively, past calibration factors for individual observers may no longer be valid if an observer's estimation procedure changes. It was pointed out that, in any case, aerial photography will be used to check the estimates of all observers. Furthermore, future surveys will include many new observers whose accuracy will not be known so the need to calibrate observers will continue. It was reiterated that if the knowledge biased observers, it might affect their precision. Since the observers are calibrated, their precision is more important than their accuracy.

OCEANOGRAPHIC CONSIDERATIONS

1997-98 ENSO Event - Fiedler

Currently, the eastern tropical Pacific is experiencing a strong El Niño/Southern Oscillation (ENSO) event, as measured by any of the three indices for it: Southern Oscillation Index, sea surface temperature anomaly, and trade wind index (Figure 1). However, the NOAA/NCEP Climate Prediction Center predicts that sea surface temperatures should be close to normal by next August (Figure 2). Fiedler said that it is possible that the favorable habitat for offshore spotted dolphins and eastern spinners (warm surface waters and shallow thermocline) expands to the south and west during an ENSO event.

Sightings From Tuna Vessels - Anganuzzi

The tuna vessel observer data presented in this set were collected 1975 to 1996, from January to December in each year. Four years were considered ENSO events: 1976-77, 1982-83, 1986-87, and 1991-92. The remaining 18 years were non-ENSO. When analyzing ENSO year data for this workshop, Anganuzzi used data collected August-November so they would be comparable to the research data.

Discussion focused on offshore spotted dolphin distributions since these stocks have a wider distribution than the eastern spinner stocks (Figures 3 and 4). Offshore spotted dolphin sighting rates were lower in ENSO years, but the area in which dolphins were seen did not change greatly. The distribution of dolphins in the year following an ENSO event was also examined; it appeared that by August of the following year distribution had returned to "normal," i.e., non-ENSO conditions.

The distribution of group sizes of offshore spotted and eastern spinner dolphins did not change during ENSO (Figure 5).

Sightings From Research Vessels - Fiedler

The research vessel observer data were primarily drawn from MOPS (1986-90), but also included other cruises conducted from 1982 to 1993. Both offshore spotted and eastern spinner dolphins appeared to expand their distributions to the west in the ENSO years 1982-83, 1986-87, and 1991-92 (Figures 6 and 7). The research vessel data exhibited a similar distribution pattern for offshore spotted dolphins as the tuna vessel data, with the exception of a concentration of dolphins south of the equator reported by the tuna vessel data. Research vessel data and tuna vessel data showed similar distribution patterns for eastern spinners.

The research vessel data reported a larger proportion of smaller schools during ENSO than non-ENSO years, although this change was not great (Figure 8). It was pointed out that if there are calmer sea conditions during ENSO periods, this could explain the change in apparent school size because more small schools would be detected.

In general, the workshop participants agreed that the current El Niño event will have minimal effect on an estimate of abundance using the proposed methods.

STUDY AREA BOUNDARIES

A large portion of the meeting was spent reviewing possible changes to the MOPS study area boundaries. MOPS boundaries were based on dolphin distributions known at the time from tuna vessel observer data. Gerrodette initiated discussion by asking the group whether the boundaries should remain the same or whether there were reasons to change them. The group was reminded that the distributions of offshore spotted dolphins and eastern spinners were the most important since these were the target species. Six general areas of change were considered: off northern Baja California, the Gulf of California, the northeast "corner," the western tip, the "dog's jaw" and overall southern line, and the southeastern area off Peru (Figure 9). The workshop participants continued to examine the boundaries relative to estimated dolphin densities and to adjust the boundaries until a consensus was reached. Overall, the study area was increased by 2.6 million km_, or about 14%, over the MOPS area.

A. Off Northern Baja California

Moving the northern boundary further north to the U.S./Mexican border was proposed. Some participants agreed with this since the range of the common dolphin population affected by the fishery extends this far north. It was pointed out that common dolphins are not a focal species. While recognizing that, it was still decided that since the ships depart from San Diego, the area could be surveyed with little additional effort and the study area would then be contiguous with the California survey area.

B. Gulf of California

The MOPS cruises did not survey in the Gulf of California, but spotted and spinner dolphins are present in the southern portion of the Gulf. It was agreed that the study area should continue into the southern part of the Gulf, up to the 28th parallel, based on observations from SWFSC research cruises in recent years.

C. Northeast "Corner"

Both tuna vessel observer data and research vessel observer data show a moderate density of spotted dolphins at the northern boundary of the MOPS study area near 120 W. The workshop participants agreed that the boundary should be expanded to the northwest, "filling in the corner."

D. Western Tip

Although it is generally beyond the area of the ETP fishery, research vessel sightings showed a significant spotted dolphin density at about 10 N/150 W. It was agreed that these dolphins should be investigated, including the acquisition of samples for genetic analysis. Also, the western tip was moved northward slightly to reflect dolphin distribution better.

E. "Dog's Jaw" and Southern Line

With a paucity of sightings in the "dog's jaw" (about 2 S/135 W), it was decided that this area could be safely eliminated. There was also no evidence of spotted dolphins in the area south of 5 N and west of 130 W.

There was considerable discussion over how to re-draw the southern boundary. The objective was to cover the range of the focal stocks without surveying unnecessary areas. It was cautioned that if the survey area expanded too far it might pick up the Polynesian population of spotted and spinner dolphins.

Concern was expressed over a cluster of spotted dolphin sightings, at about 5 N/120 W, made from tuna vessels that were log or school fishing. It was proposed that the southern boundary of the survey be extended to cover this region since it is unclear if the small number of sightings there are due to low densities or to low searching effort.

The suggestion was offered that the southern boundary for these stocks might be determined by cold water and that looking at this year's annual variation might provide the boundary. It was pointed out, however, that in this region the oceanic environmental gradient is oriented east to west, not north to south.

Participants finally decided that the boundary should extend far enough out into low-density areas to provide a several hundred mile "buffer" around all the high density core areas. Expanding the boundary in this region added little effort cost since it would be a low-density sampling stratum.

It was noted that during MOPS the actual track lines didn't touch the boundary. The group concurred that the boundaries should be touched in the upcoming survey.

F. Southern Area Off Peru

Tuna vessel data indicated a high density of spotted dolphins in the southeastern part of the study area at about 10 S/90 W. Tuna vessel sightings from the 1970's in the same area were brought forward for the group to review. Participants debated whether or not to increase the study area here. Concern was expressed over the large interannual variability of sightings south of the equator, and whether or not the density "hotspot" visible on the chart was an artifact of smoothing. It was pointed out that if there was an abundance of tuna and dolphins in this area there would be more fishing effort there. Eventually, the group decided it was best to investigate this area, especially during the first year when three ships would be used. The southeastern most area was increased to 18 S and 90 W.

Comparability

Several workshop participants expressed concern that changing the boundaries would affect the comparability of data with MOPS. There are two somewhat conflicting goals of the survey: to gather data comparable to MOPS, and to obtain the best estimate of abundance. Gerrodette is committed to obtaining the best estimate of abundance, even if this means compromising some comparability with MOPS. During the analysis phase, comparability with MOPS can be achieved by analyzing common areas with common methods. Thus, it should be possible both to get better estimates of abundance and also to produce a consistent time-series.

TRACKLINE PATTERN

Comparability of data with MOPS was also an issue in determining the trackline pattern. Since 1991, SWFSC surveys have used a systematic random grid pattern. MOPS used a variable random design. It was pointed out that a grid pattern is less efficient and

can be difficult to complete. With a flexible design it is easier to make adjustments due to weather. The "dead time" spent transiting between lines in a grid pattern was mentioned. This problem is exacerbated in a large study area such as this one. It was recommended to change the lines from year to year if the survey was not intended for monitoring populations. Not following MOPS lines was another recommendation. Caution was advised with flat boundaries and the need to "bounce off" boundaries randomly was stressed. Even though the MOPS survey lines did not touch the boundaries, it was advised that this not be repeated even for comparability. No consensus was reached on whether tracklines should be random grid or random "zig-zag," although it was agreed that the latter would be easier logistically. It was also agreed that steaming at night was a good idea. This would cover more area, make each day's visual effort more independent from the others, and allow for acoustic searching at night.

SECOND OBSERVER TEAM

The use of a complete, second, independent team was considered. This might be possible with the R/V WORTHY because that ship has extra berthing. Recent SWFSC surveys have used an independent observer to estimate the proportion of sightings missed along the trackline. It was pointed out that in closing mode it was not possible for a second team to be truly independent. The group concurred that the existing single independent observer was best for closing mode.

STRATIFICATION

It was recognized that a weakness of the MOPS survey was the few sightings of coastal stocks. In particular, estimates of abundance are needed for Central American spinner dolphins and the newly proposed stock of Tres Marías spinner dolphins, and improved estimates are needed for coastal spotted dolphins and long-beaked common dolphins. Plots of sightings from both research and fishing vessels showed that most of these coastal dolphin stocks are seen along the continental shelf break, between the 200 and 1000 meter contour lines (Figures 10-13). A coastal stratum inside the 1000 meter line was proposed, to be surveyed with twice the effort than the area outside the line. The reasoning for the extra effort was that the coastal habitat is a relatively small geographic area and therefore the ships would otherwise be spending only a small amount of time surveying there. The question arose whether or not these were important stocks. It was opined that it is important to obtain estimates of abundance for these stocks in order to assess their status. The effect of the fishery on these stocks has not yet been estimated. Stratification would be necessary to get abundance estimates for these stocks.

Gerrodette queried the group about the need to stratify core areas of high density. This was done in MOPS with the intent of reducing estimate variance by having more effort in denser areas. The suggestion was made to use the eastern spinner distribution as a basis for the core stratum, since it encompasses the northeastern offshore spotted dolphin distribution and the adjacent coastal area. This was followed by a proposal to base the core boundary on the distribution of the northeastern offshore spotted dolphin stock (5 N/ 120 W), which would be nearly the same. Optimum allocation of sighting effort, with

more effort in higher density areas, was discussed but no definite conclusion was reached. It was recommended to re-examine the MOPS data to see what allocation of effort would result in minimum variance in the abundance estimate. Another criterion, such as target precision, might be factored into the weighting of effort.

Four strata were proposed: coastal, core, medium, and outside (low) density areas. Several participants thought four areas would be too difficult to accomodate with survey lines, and suggested three: coastal, core, and outside. No decision was reached on whether there should be three or four strata, but a re-examination of MOPS data may help determine this.

The end of the stratification discussion led to the question of there being a beginning-to-end review of MOPS, resulting in a paper trail. Abundance estimates were calculated from the data, but no "post-mortem" of the survey design had been conducted. The field situation of MOPS was more variable than expected, resulting in somewhat less effort and somewhat higher estimates of variance than had been expected. The suggestion was made to conduct a review of MOPS to see how well the survey design had provided the information that had been desired. Such a review could be helpful in designing the present survey.

PHOTOGRAMMETRY

A few survey days per 120 are "lost" to photogrammetric projects. The workshop participants agreed that the trade-off of a few days of line-transect effort was worth obtaining the data on stock definition, reproduction, and size.

FINAL COMMENTS

At the close of the meeting Gerrodette asked for a final round of comments from the workshop participants. Several participants did not offer final comments. Others made the following remarks.

Fiedler thought the proposed design was a good one, but that a lot would still depend on ship practicalities. Barlow cautioned against over-stratification: the small amount of efficiency gained would require a large amount of extra work. He suggested strong density gradients be used to determine stratification. Laake supported Barlow's comments against over-stratification if strong density gradients were not present. Goodman concurred with Fiedler's comment on logistics and recommended using the simplest design possible. Goodman questioned whether the survey would answer the ultimate management question. He also asked if there were preparations for questions that would be asked later. Laake agreed with Goodman, saying there should be more focus on what needs to be answered by the survey. He thought consideration should be given to how management decisions would impinge upon survey design. Forney reiterated that there was a conflict between backward MOPS comparability and making use of updated information and techniques when designing the current survey. She recommended documenting on paper why changes were made to the previous survey design and making this an explicit part of the design process.

Although Michael Scott was not present during the final round of comments, on the previous day he offered one strong recommendation: the ship with the helicopter should survey the areas with Stenella longirostris centroamericana because the school sizes are so large, and the greatest variation in observer estimates is with large schools.

Tillman thanked everyone for making the effort to attend. He stated that SWFSC would be issuing documents related to the congressional research directive and would be convening future meetings. This meeting was the first step in a process. The workshop participants would be further consulted before the survey design was finalized.

Draft copies of this report were sent to all workshop attendees on January 21, 1998 for revision and comments.

APPENDIX 1

Attendees

APPENDIX 2

Agenda